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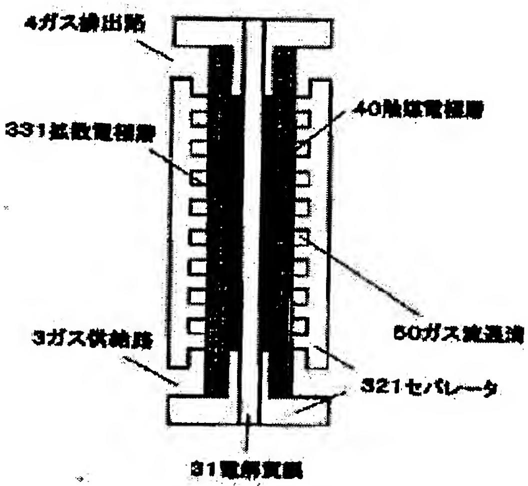
(54) SOLID POLYMER ELECTROLYTE TYPE FUEL CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a solid polymer electrolyte type fuel cell having a simple system and a compact device by providing a humidifying means without using a humidifying tank, a heating device for a pipe, and a humidifying cell conventionally.
SOLUTION: This fuel cell is formed by a plurality of cells, which are provided with anode electrodes and cathode electrodes comprising catalyst electrode layers 40 and porous diffusion electrode layers 331 disposed sandwiching the solid polymer electrolyte type fuel cells, and separators 321. The separator 321 is provided with a reaction gas flow groove 50 in a part opposite to the catalyst electrode layer 40, a gas feed path 3 for feeding the reaction gas from a gas inlet manifold to the reaction gas flow groove, and a gas exhaust path 4 leading the unused reaction gas from the reaction gas flow groove to the gas outlet manifold. The diffusion electrode layer 40 is disposed opposed to the reaction gas flow groove 50, the gas feed path 3, and the gas exhaust path 4.



CLAIMS

[Claim(s)]

[Claim 1]An anode electrode and a cathode terminal which consist of a catalyzer electrode layer and a porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane.

A separator.

Are the above the solid polyelectrolyte type fuel cell which it had, and said separator, While having a reactant gas circulating groove into said catalyzer electrode layer and a portion which counters, A gas supplying path which supplies reactant gas from said gas inlet manifold to said reactant gas circulating groove, It has a gas exhaust passage which leads intact reactant gas to said gas outlet manifold from said reactant gas circulating groove, and said diffusion electrode layer was countered and allocated in said reactant gas circulating groove, said gas supplying path, and said gas exhaust passage.

[Claim 2]A solid polyelectrolyte type fuel cell forming a humidifying water supply means for supplying water for reactant gas humidification to a portion which counters said gas supplying path of said diffusion electrode layer in the fuel cell according to claim 1.

[Claim 3]A solid polyelectrolyte type fuel cell establishing a diffusion-zone cooling method for cooling a diffusion electrode layer in the fuel cell according to claim 1 into a portion which counters said gas exhaust passage of said diffusion electrode layer.

[Claim 4]An anode electrode and a cathode terminal which consist of a catalyzer electrode layer and a porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane, In a solid polyelectrolyte type fuel cell which laminates two or more cells provided with a separator which has a gas distribution groove which counters said two electrodes, respectively, is provided and is open for free passage to a manifold for reactant gas supply, A solid polyelectrolyte type fuel cell equipping a porous body allocated in an inside of said manifold, and this porous body with a humidifying water supply means for supplying water for reactant gas humidification.

[Claim 5]A solid polyelectrolyte type fuel cell, wherein said porous body consists of electric insulation materials, such as resin or Ceramics Sub-Division, in the fuel cell according to claim 4.

[Claim 6]A solid polyelectrolyte type fuel cell, wherein the fine-pores average diameter shall be distributed over the range of 40 micrometers from 15 micrometers and fine pores not less than 20 micrometers in diameter shall have said porous body not less than 50% in the fuel cell according to claim 4 or 5.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to a solid polyelectrolyte type fuel cell and the structure which humidifies that solid polyelectrolyte membrane especially.

[0002]

[Description of the Prior Art]The composition of the cell (henceforth a cell) which is generally the minimum power generation unit of a solid polyelectrolyte type fuel cell is expressed like drawing 8. A membrane electrode zygote (MEA:Membrane Electrode Assembly) joins the catalyst bed 40 (henceforth a catalyzer electrode layer) containing the precious metals (mainly platinum) to both sides of the electrolyte membrane 31, and is formed in them. It serves to tell current outside at the same time there is the porous diffusion zone 33 (henceforth a diffusion electrode layer) in the outside of MEA and it passes the fuel gas and oxidant gas as reactant gas. A porosity raw material, for example, (carbon paper TGPH-60:Toray Industries make), is used for a diffusion zone so that the reactant gas which flows through a gas distribution groove may be uniformly spread in an electrode.

[0003]The porous diffusion zone 33 and the catalyst bed 40 are doubled, and the side to which conduction of an anode electrode and the oxidant gas is carried out in the side to which conduction of the fuel gas is carried out is called cathode terminal. A diffusion zone may be included in MEA in a broad sense. A cell is constituted by inserting the above-mentioned two electrodes with the separator 32 provided with the fuel-gas-flow groove and the oxidant gas circulating groove. What laminated a majority of this cell is called stack.

[0004]The polymer material of the fluorine system is most generally used for the electrolyte membrane. There is Nafion™ (the U.S. and Du Pont trade name) in the electrolyte membrane of typical marketing. The features of these electrolyte

membranes are that proton conductivity is high as compared with other polymer electrolytes, and that proton conductivity will fall rapidly if an electrolyte membrane dries. For this reason, always controlling an electrolyte membrane by a solid polyelectrolyte type fuel cell to a suitable moisture state is called for. Usually, desiccation of an electrolyte membrane is prevented by humidifying reactant gas.

[0005]Drawing 9 is a typical sectional view of cell constitution where drawing 8 differs in part. In the polyelectrolyte type fuel cell shown in drawing 9, Although the catalyzer electrode layer 40 and the diffusion electrode layer 33 are allocated in the both sides of the electrolyte membrane 31 of a solid polymer, these are pinched with the cathode side separator 32k which has the gas distribution groove 50, and the anode side separator 32a and the cell single cell is constituted, The circulating-water-flow groove 60 for cooling generation of heat by a power generation reaction has processed it into one side of the separator shown in drawing 9.

[0006]The defects-of-gas-accumulation part which contributes to distribution of the reactant gas to each cell and a set of the emission gas from each cell is called a manifold, and conduction of the reactant gas is carried out to the gas distribution groove of a separator from this manifold. The internal manifold form of the structure formed in the same field as those with two kind and a cell as a structure form of a manifold so that it may mention later, and a cell have the outer manifold form formed as another structure.

[0007]Drawing 10 shows the typical perspective view of said outer manifold form. The outer manifold is attached to each lamination side of the stack 100 which laminates two or more cells 60. 81 in a figure shows a fuel gas inlet manifold, 82 shows an oxidant gas inlet manifold, for example, and the outlet manifolds which are not illustrated to an opposed face, respectively are provided. The object for the fuel gas of the separator in drawing 10 and the gas conduction slot 50 for oxidant gas are formed so that it may go direct mutually, respectively, and distribution supply of the reactant gas is carried out from each manifold to each gas conduction slot 50.

[0008]Drawing 11 shows the structure of the conventional cell which adopted said internal manifold form. Drawing 12 shows the front view of a separator and drawing 11 is a figure showing the A-A section in drawing 12 notionally. In order to understand easily, unlike the cross sectioned direction of drawing 12, a cross sectioned direction is changed for convenience, and the gas distribution groove 50 in drawing 11 shows a ctenidium-like gas distribution groove section. Drawing 11 shows the example which formed the gas distribution groove only in one side by the side of the electrode of a separator.

[0009]Although the composition of the cell in drawing 11 is similar with drawing 9, it differs in that the separator 32 is provided with the gas supplying path 3 and the gas exhaust passage 4. In drawing 11, the graphic display of the manifold part in drawing 12 is omitted, and drawing 12 explains the flow of reactant gas, etc.

[0010]As shown in drawing 12, the separator 32 forms the gas distribution groove 50 in the center section of a rectangle, nothing, and this rectangle principal surface for that principal surface, The gas supplying path 3 and the gas exhaust passage 4 which are shown in the both-ends adjacent part of this gas distribution groove 50 by figure top hatching are opened for free passage and established in said gas distribution groove face to face, And the fuel gas inlet manifold 1 and the fuel gas outlet manifold 2 which were provided, for example on the diagonal line are made to open this gas supplying path 3 and gas exhaust passage 4 for free passage.

[0011]On a different diagonal line, the oxidant gas inlet manifold 5 and the oxidizing agent gas outlet manifold 6 are formed, and the inflow of cooling water 7 and the exit 8 are formed in the middle of each of said manifold face to face. A stack is formed by laminating vertically or horizontally two or more electrolyte membranes 31 shown in such a separator and drawing 11, electrode catalyst layers 40, and diffusion electrode layer 33 grades in the direction of the same axle. In that case, between each separator, the component for gas seals is inserted suitably, and it fixes mechanically by a proper clamping means, and is considered as a stack.

[0012]By the way, as mentioned above, in order that the solid polyelectrolyte membrane used for a solid polyelectrolyte type fuel cell may show high ion (proton) conductivity in the damp or wet condition having contained water, a high battery characteristic is obtained by humidifying reactant gas with water.

[0013]The portion near the exit of the reactant gas inside a cell is comparatively easy to maintain solid polyelectrolyte membrane at a damp or wet condition, since many water (steam) generated at the reaction of the upstream is contained in gas. On the other hand, especially near the entrance of reactant gas, the water (steam) away held in the circulating reactant gas increases in number more than the produced water by a reaction, solid polyelectrolyte membrane dries, and partial characteristics degradation is caused.

[0014]The method (external humidification system) of supplying, after humidifying reactant gas as a method of humidifying reactant gas by the tank for humidification etc. which were established in the exterior of the stack, The humidification cell of a size/form similar to a cell is included in a part of stack, and how (internal humidification system) to supply the reactant gas which passed along the

humidification cell to a power generation part is considered.
[0015]For example, as an external humidification system, aeration of the reactant gas is carried out into the water stored by the container for humidification, As the thing constituted so that conduction of the reactant gas degassed from the water might be carried out to a laminated fuel cell, and an internal humidification system, It is what pinched the water transmission film via porous support with the separator which has a gas distribution groove, and the separator which has a humidifying water circulating groove, constituted the humidification board on the whole, and was constituted so that reactant gas might be humidified via the water transmission film as a humidification film.
[0016]
[Problem to be solved by the invention]As mentioned above, although it was important to maintain solid polyelectrolyte membrane at the optimal damp or wet condition, there were the following problems in a solid polyelectrolyte type fuel cell including the conventional humidification system.
[0017]Although a cell is supplied through piping etc., if it is condensed as the gas which was humidified in the case of the aforementioned external humidification system reaches a membrane electrode zygote (MEA), and waterdrop is made, it will become a cause which waterdrop enters [cause] in a gas distribution groove, makes a slot blockade, and causes characteristics degradation. In order to avoid this, the condensation prevention treatment of heating a piping system is needed, and there is a problem which becomes complicated [a system].
[0018]In the case of the aforementioned internal humidification system, only the part of a humidification cell needs to add a component member equivalent to an expensive cell, and there is a problem on which cost goes up in it.
[0019]This invention was made in view of the above-mentioned point, and there is problem of this invention in providing the solid polyelectrolyte type fuel cell provided with the humidification means which becomes a system is simple and compact [equipment] not using a humidification tank, the heating apparatus of piping, a humidification cell, etc. as mentioned above.
[0020]
[Means for solving problem]In this invention in order to solve the above-mentioned problem, The anode electrode and cathode terminal which consist of the catalyzer electrode layer and the porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane, In the solid polyelectrolyte type fuel cell which laminates two or more cells provided with the separator, supplies reactant gas

to said each cell from a gas inlet manifold, and discharges intact reactant gas from a gas outlet manifold, While said separator has a reactant gas circulating groove into said catalyzer electrode layer and the portion which counters, The gas supplying path which supplies the reactant gas from said gas inlet manifold to said reactant gas circulating groove, It has a gas exhaust passage which leads intact reactant gas to said gas outlet manifold from said reactant gas circulating groove, and said diffusion electrode layer is countered and allocated in said reactant gas circulating groove, said gas supplying path, and said gas exhaust passage (invention of Claim 1).

[0021]As mentioned above, since this diffusion electrode layer is in contact also with MEA by countering and installing a diffusion electrode layer in the gas supplying path of the preceding paragraph of the gas distribution groove in a cell, or a latter gas exhaust passage, Moisture moves via a diffusion electrode layer between a gas supplying path, exhaust passage, and MEA(s), and distributed gas, emission gas, and the moisture control of MEA become possible.

[0022]When the humidified reactant gas condenses in the middle of piping to a cell, the water of condensation serves as a droplet, enters in a cell, and contacts a diffusion electrode layer in a gas supplying path. Since it consists of porous materials, a diffusion electrode layer absorbs moisture by capillarity, and if MEA is dry, moisture will move it to MEA. If a dry gas is supplied when MEA has got wet superfluously, it will dry and excessive moisture will move the diffusion electrode layer of a gas supplying path from MEA. Thus, moisture can move between MEA and distributed gas via a diffusion electrode layer, and MEA can maintain the state where moistness was carried out moderately.

[0023]As an embodiment in connection with the diffusion electrode layer of invention of said Claim 1, the following is preferred. That is, in the fuel cell according to claim 1, the humidifying water supply means for supplying the water for reactant gas humidification to the portion which counters said gas supplying path of said diffusion electrode layer should be formed (invention of Claim 2).

[0024]For example, by supplying water to a diffusion electrode layer of a portion which faces a gas supplying path through a water supply route, this water evaporates in a gas supplying path, and gas is humidified. When MEA is dry, a diffusion electrode layer can be moved and moisture can be supplied to MEA.

[0025]In said fuel cell according to claim 1, a diffusion-zone cooling method for cooling a diffusion electrode layer into a portion which attends said gas exhaust passage of said diffusion electrode layer should be established (invention of Claim 3).

[0026]For example, temperature of a diffusion electrode layer of this portion can be

reduced by cooling the back of a separator which touches a diffusion electrode layer of a portion which counters a gas exhaust passage by cooling water. If temperature of a diffusion electrode layer is low, a steam contained in emission gas will condense in a diffusion electrode layer, and will become water of a liquid. Since this water is returned to MEA through a diffusion electrode layer, it can maintain a damp or wet condition of MEA.

[0027]Invention of Claim 4 is preferred as a different means for solving said problem. Namely, an anode electrode and a cathode terminal which consist of a catalyzer electrode layer and a porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane, In a solid polyelectrolyte type fuel cell which laminates two or more cells provided with a separator which has a gas distribution groove which counters said two electrodes, respectively, is provided and is open for free passage to a manifold for reactant gas supply, A porous body allocated in an inside of said manifold and this porous body should be equipped with a humidifying water supply means for supplying water for reactant gas humidification.

[0028]As an embodiment in connection with a diffusion electrode layer of invention of said Claim 4, the following is preferred. That is, let said porous bodies be electric insulation materials, such as resin or Ceramics Sub-Division, in the fuel cell according to claim 4 (invention of Claim 5).

[0029]In the fuel cell according to claim 4 or 5, the fine-pores average diameter shall be distributed over the range of 40 micrometers from 15 micrometers, and fine pores not less than 20 micrometers in diameter shall have said porous body not less than 50% (invention of Claim 6).

[0030]According to invention of above-mentioned Claim 4, since water is supplied to a cylindrical porous body installed in an inside of a manifold, dry reactant gas receives supply of moisture from a porous body easily, and is humidified. A manifold and a single cell adjoin, migration length is slight and there is no risk of also condensing temperature, before moisture in humidification gas reaches MEA, since identitas or the manifold is a little lower, and forming droplet. Since a cylindrical porous body is installed in an inside of space of a manifold, a stack size is not expanded like [in a case of providing a humidification cell].

[0031]Like invention of said Claim 5, a short circuit between cells by a porous body can be prevented by using a porous body as electric insulation material.

[0032]According to invention of said Claim 6, the retaining performance of the water in the fine pores of a porous body becomes the optimal, Since moisture supply in movement of the water within porosity and gas can carry out suitably, without the

movement speed of the water within porosity falling and the unevenness of a moisture content arising in the length direction, it becomes possible to supply the humidification gas which does not have a bias in the whole stack.

[0033]

[Mode for carrying out the invention]Based on Drawings, the working example of this invention is described below.

[0034]Drawing 1 is an working example in connection with invention of Claim 1, and shows the typical sectional view of the cell equivalent to drawing 11. The same number is given to the same component as drawing 11, and explanation is omitted. The point of difference between drawing 1 and drawing 11 is a point of having changed the contact portion with a diffusion electrode layer so that it might extend and the diffusion electrode layer 331 might be formed so that the gas supplying path 3 and the gas exhaust passage 4 may be attended, and the separator 321 might also tend to have installed said extension, in drawing 1.

[0035]According to the above-mentioned composition, reactant gas goes into the gas supplying path 3 first, and contacts the diffusion electrode layer 331. When the water of condensation serves as a droplet and is contained in reactant gas, the water of condensation is absorbed by the diffusion electrode layer 331, and moves to MEA through a diffusion electrode layer. Therefore, the water of condensation enters a gas distribution groove, and does not blockade a slot. When reactant gas is conversely dry, in order that the produced water which has moved from MEA through a diffusion zone may evaporate in a diffusion zone and may humidify reactant gas, MEA does not dry with reactant gas.

[0036]Drawing 2 is an working example in connection with invention of Claim 2, and shows the type section figure of the cell which added the humidifying water supply route 65 as a humidifying water supply means to the portion which faces the gas supplying path 3 of the diffusion electrode layer 331. The water which this humidifying water supply route penetrated the separator 322, was provided, and was supplied to the diffusion electrode layer 331 through the humidifying water supply route evaporates in the gas supplying path 3, and humidifies reactant gas. When MEA is dry, the diffusion electrode layer 331 can be moved and moisture can be supplied to MEA. As water to supply, when using fuel cell cooling water, warm water comparable as cell temperature can be supplied, and the energy loss at the time of humidifying reactant gas can be lessened.

[0037]Drawing 3 is an working example in connection with invention of Claim 3, and shows the type section figure of the cell which added the diffusion-zone cooling

channel 66 as a diffusion-zone cooling method for cooling a diffusion electrode layer near [facing the gas exhaust passage 4 of the diffusion electrode layer 331] the portion. This diffusion-zone cooling channel 66 penetrates the separator 323, and is provided, and the temperature of the diffusion electrode layer 331 can be reduced by cooling the back of the separator which touches a diffusion electrode layer by cooling water. If the temperature of a diffusion electrode layer is low, the steam contained in emission gas will condense in a diffusion electrode layer, and will serve as water of a liquid. Since this water is returned to MEA through a diffusion electrode layer, it can maintain the damp or wet condition of MEA.

[0038]the fuel cell stack which drawing 4 is an working example in connection with invention of Claim 4, and adopted internal manifold form is notional -- a notching perspective view is shown in part.

[0039]In this working example, fuel gas and oxidant gas are supplied / discharged from the internal manifold formed in the same field as a cell like the composition explained by drawing 12. The fuel gas which uses hydrogen as the main ingredients from the reformer which is not illustrated is flowing into the fuel gas inlet manifold 1, and air is flowing into the oxidant gas inlet manifold 3 from the air compressor (compressor) which is not illustrated. Cover abbreviated [of a stack longitudinal direction / whole] and in the center of the oxidant gas inlet manifold 3. The cylindrical porous body 55 is allocated and this cylindrical porous body 55 is connected via the connecting member for water supplies which those both ends do not illustrate with the tube 67 for water supplies in the portion of the end plate 71 for stack bolting.

[0040]In the oxidant gas inlet manifold 3, after the dry air contacts the cylindrical porous body 55 having contained water and is humidified, it flows into the gas distribution groove of each cell 60, and is used for a reaction (power generation).

[0041]In this example, since it is generated by many steams at the time of refining of raw materials and mineral fuel, the porous body for humidification is not installed in the fuel gas inlet manifold 1, but depending on the preparation method of fuel gas, the porous body for humidification can be suitably installed also in the fuel gas inlet manifold 1.

[0042]Glass, resin, etc. may be used as the main ingredients although the porous body 55 uses Ceramics Sub-Division which uses alumina as the main ingredients in this example. As for a porous body, as mentioned above, what the fine-pores average diameter shall be distributed over the range of 15 to 40 micrometers, and fine pores not less than 20 micrometers in diameter have not less than 50% is preferred.

[0043]Although drawing 5 is an working example in connection with invention of Claim

4 like drawing 4, drawing 4 shows a different working example. In this example, oxygen is flowing into the fuel gas inlet manifold 1 through a reducing valve, respectively from the oxygen cylinder which hydrogen gas does not illustrate from the hydrogen cylinder which is not illustrated to the oxidant gas inlet manifold 5. Since each manifold of the parts numbers 2, 6, 7, and 8 is equivalent to drawing 12, explanation is omitted. At this example, by use of pure water matter and pure oxygen, since there are few flows of distributed gas, the manifold serves as flat state and a thing tabular in the porous body 56 currently installed in the inside is used. Thus, according to the form of a manifold, the porous body of various form, such as sheet metal and trianglepole shape, can be used.

[0044]Drawing 6 shows the working example from which drawing 4 differs further. Although this example shows the perspective view of the stack of outer manifold form and is the composition and substantially the same ** of drawing 10, it differs in that the porous body 57 was formed in the oxidant gas inlet manifold 82. It is flowing into the fuel gas inlet manifold 81 from the reformer which the fuel gas which uses hydrogen as the main ingredients from the lower part does not illustrate, and air is flowing into the oxidant gas inlet manifold 82 from the air compressor (compressor) which is not illustrated. During power generation, it is constituted so that a proper quantity of water may be supplied to the porous body 57.

[0045]in addition -- in drawing 6 -- the porous body 57 -- hollow -- it supposes that it is tubular and oxidant gas can be introduced from this centrum to space of an oxidant gas inlet manifold via a porous body. Anyway, in the inside of a manifold, if the gas humidification inside a manifold is simply feasible by emitting the water contained in a porous body, form, a setting position, etc. of a porous body may have various modification within the limits of this technical idea.

[0046]Drawing 7 examines aging of stack voltage on the fuel cell which becomes an working example of said invention of this, and the result compared with conventional technology about the stability of a fuel cell is shown. The vertical axis of drawing 7 shows stack voltage V, and a horizontal axis shows operation lapsed time (minute). The number of cell laminations of the stack for an examination was made into 20 pieces, and driving current density was made into $0.6A/cm^2$ (70 **).

[0047]In the working example of this invention shown as a solid line (A), a temporal voltage change was not seen among the figure. On the other hand, in the stack shown with the alternate long and short dash line (C) which does not humidify among conventional technologies, voltage began to fall immediately after the start up, and sag was expanded gradually. In the stack shown with the dashed line (B) which performed

external humidification using the humidification tank, although rapid sag was not produced, the fall (change) of voltage was accepted intermittently. This is considered to originate in some humidifying water condensing, building droplet and blockading the gas passageway.

[0048]It turns out that it excels in the fuel cell which applied this invention being able to prevent desiccation near the reactant gas entrance, and it also preventing generating of droplet and stabilizing cell voltage so that clearly from this result.

[0049]

[Effect of the Invention]The anode electrode and cathode terminal which consist of the catalyzer electrode layer and the porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane according to [above-mentioned passage] this invention, In the solid polyelectrolyte type fuel cell which laminates two or more cells provided with the separator, supplies reactant gas to said each cell from a gas inlet manifold, and discharges intact reactant gas from a gas outlet manifold, While said separator has a reactant gas circulating groove into said catalyzer electrode layer and the portion which counters, The gas supplying path which supplies the reactant gas from said gas inlet manifold to said reactant gas circulating groove, Have a gas exhaust passage which leads intact reactant gas to said gas outlet manifold from said reactant gas circulating groove, and said diffusion electrode layer, Allocate in said reactant gas circulating groove, said gas supplying path, and said gas exhaust passage face to face, and in or. Or the anode electrode and cathode terminal which consist of the catalyzer electrode layer and the porous diffusion electrode layer which were allocated on both sides of solid polyelectrolyte membrane, In the solid polyelectrolyte type fuel cell which laminates two or more cells provided with the separator which has a gas distribution groove which counters said two electrodes, respectively, is provided and is open for free passage to the manifold for reactant gas supply, By having equipped the porous body allocated in the inside of said manifold, and this porous body with the humidifying water supply means for supplying the water for reactant gas humidification, Not using a humidification tank, the heating apparatus of piping, a humidification cell, etc., a system is simple like before, It can have a humidification means which becomes compact [equipment], and the damp or wet condition of MEA can always be kept the optimal, and it becomes possible to provide the solid polyelectrolyte type fuel cell which can obtain high cell voltage.